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Good morning Chairman Boehlert, Congressman Gordon, and members of the committee. My name is Krish Doraiswamy, and I am a Research Planning Manager for DuPont Central Research & Development. In that role I am responsible for coordinating and monitoring DuPont's research & development activities in Nanoscale Science and Engineering (what we refer to as NS&E), and for developing and nurturing collaborative R&D relationships. I appreciate this opportunity to share our views on the research needed to address the Safety, Health and Environmental (SHE) implications of nanotechnology.

DuPont is a science driven company with a commitment to safety, health and environmental protection. As a 200 year-old company, we have participated in the development and evolution of many technologies, and we are proud to have contributed significantly to the advancement of scientific knowledge. At DuPont, we use science to develop products and services that improve the quality and safety of people's lives. We also use science and our commitment to safety to guide how we develop, manufacture and manage our products throughout their life cycle.

Today, my testimony will make three points:

- Broad applications of nanoscale materials will emerge faster if we understand the safety, health and environmental implications.
- Cooperative efforts are needed to resolve key uncertainties, and I will provide examples of what DuPont is doing today to address these uncertainties.
- There is a need for increased research funding that is more strategically targeted to address fundamental safety, health and environmental questions.

The need to understand SHE implications of nanoscale materials

DuPont's interest in nanoscale materials is a natural extension of our rich and deep knowledge base in materials science and its applications. The nanostructure of materials has been a fundamental determinant of a material's properties long before NS&E and nanotechnology were identified as distinct fields of study. Certain nanoscale materials (such as carbon black, pigments, magnetic storage media, and silver-based photographic chemicals) have been in commercial use for decades, or even centuries.

However, the emergence of new tools and techniques for the measurement, characterization and control of nanoscale features gives rise to many new opportunities. We can more precisely tailor known materials to more effectively deliver desired properties and to enhance functional benefits. For example, new polymer nanocomposites can be stronger, lighter, smarter and use less resources than conventional plastics. In addition, and more importantly, the new tools and techniques enable new generations of nanoparticulate materials and nanostructures that can create entirely new product possibilities. These new

materials may, for example, enable advances in medicine, new devices and display technologies, and new approaches to energy generation and storage.

While this rapid expansion of knowledge is creating new opportunities, it is also raising new questions about nanoscale materials, and their potential impact on health, safety and the environment. Many of these questions are of particular relevance to particles that are specifically engineered to exhibit new behaviors and that measure less than 100 nanometers on at least one dimension. Such questions include:

- How do free nanoparticles with novel properties interact with the physiology of humans or other species?
- How is this interaction the same as or different from the behavior of the comparable bulk materials?
- What are the pathways by which exposure to such free nanoparticles can occur, and how can this exposure be measured and controlled?
- Do we have generally accepted tools and methods to answer these questions?

These questions must be addressed as new nanoscale materials move into the market. However, the absence of generally accepted testing methods and standards, and the lack of scientifically validated data threatens to slow down innovation and significantly delay the introduction of new products and applications. An important fact is that many of the most interesting discoveries relating to new nanoscale materials are being made in universities and by entrepreneurs in start-up companies. These entities may lack the experience, resources and funding needed to adequately address the fundamental safety, health and environmental questions. It is our belief that such broadly relevant questions should be a significant part of the national agenda for research in NS&E.

Because nanoparticles do not necessarily behave like their larger particle relatives, research is needed to develop a uniform, science-based approach for identification of hazards, assessment of exposure and management of risks. This research requires immediate attention.

The need for a cooperative effort, and what DuPont is doing

These questions are being widely discussed and considered by federal agencies, public and private special interest organizations, and in several industry, scientific, national and international forums. We believe that all parties with an interest or a stake in the responsible development and use of these new materials should work together to allow nano-scale science and engineering to reach its full potential. Specifically, we advocate collaboration in the development of responsible safety standards and test methods; the coordination of research to generate reliable, peer reviewed data; and the establishment of appropriate oversight. DuPont is leading or actively participating in programs that seek to address each of these issues. We have taken several actions in order to contribute to the responsible development and use of nano-scale materials, including:

- DuPont coordinated the launch in June 2005 of a consortium of parties interested in nanoparticle occupational safety and health. This is a multi-stakeholder consortium of more than 14 industry, academic and government organizations formed to sponsor research that will further our understanding of factors relevant to the assessment and control of occupational exposures to engineered nanoparticles.

  This two year research project will be led by DuPont scientists and will help us understand (a) How airborne nanoparticles may behave in the workplace; (b) How to monitor and measure occupational exposures to airborne nanoparticles; and (c) How to assess the penetration of engineered nanoparticles through candidate barrier materials for personal protective equipment.

Members of this consortium include: DuPont, Procter & Gamble, Dow Chemical, Air Products & Chemicals, Inc., Degussa, Rohm & Haas, PPG, Intel Corporation, the UK Health & Safety Executive, and the Department of Energy Office of Science.

- We are working with a broad industry group (the Chemstar Panel on nanomaterials, within the American Chemistry Council). This panel is developing recommendations for the EPA and for the chemical industry regarding safety, health and environmental issues and regulatory guidelines for nanoscale materials. As part of this effort, we participated with the Ad Hoc Nano Working Group of the U.S. EPA's National Pollution Prevention and Toxics Advisory Committee (NPPTAC) to develop options for the EPA regarding a voluntary reporting program to share and generate data on nanoscale materials.

- We are supporting research at the Rice University Center for Biological and Environmental Nanotechnology (CBEN), and are founding members of ICON, the International Council on Nanotechnology, also based at Rice University. ICON is a multi-stakeholder group, with representation from industry, academia, regulatory and non-governmental organizations to "assess, communicate, and reduce nanotechnology environmental and health risks while maximizing its societal benefit." More information about ICON is available at www.icon.rice.edu.

- We have entered into an agreement with Environmental Defense to jointly develop a framework that can be used to identify, manage and reduce potential health, safety and environmental risks of nano-scale materials across all lifecycle stages. This work is just getting started, and we expect to consult extensively with other stakeholders during the project.

- In addition to these cooperative efforts, We have an active internal Product Stewardship program on nanomaterials, including toxicity assessments of lung responses. We are studying nanomaterials in commercial development as well as generic nanoscale particles, and comparing their effects to standard reference particle-types.

In summary, we are dealing with nanoparticle SHE questions as a work in progress on many fronts, with broad engagement of other stakeholders to develop robust guidelines.

However, these efforts go only part of the way toward developing the strong foundation of knowledge and tools that are needed by the NS&E community. Fortunately, there has been progress on other fronts. For example, a report issued last month by the International Life Sciences Institute Research Foundation/Risk Science Institute (ILSI), and funded by the EPA, recommends the first elements of a screening strategy to characterize the potential human health effects from exposure to nanomaterials. DuPont toxicologist David Warheit was a contributor to the development of the ILSI report.

DuPont applauds these efforts to carefully define the research that is needed, and we believe they provide a good initial foundation for a broad SHE-focused research strategy. We believe that broadly representative organizations such as the National Academy of Sciences could play a role in the further development of this strategy. In particular, we endorse the pressing need for research in the following areas:

- Understanding the critical physical, biological, and chemical parameters that characterize nanomaterials;
- Measuring, at an appropriate level, the presence of nanomaterials in the environment and particularly in the workplace;

- Understanding and predicting the environmental fate of nanomaterials with particular attention to persistence and bioaccumulation;
- Developing toxicity tests for hazard assessment of nanomaterials, with particular attention to validated in vitro screening tests, to the extent practical, and applying these tests to establish baseline criteria for evaluation of nanomaterials.

The need for increased and strategically targeted SHE research funding.

In our opinion, the research that has the highest priority relates to the development of the practical knowledge base that is described above, and the development of tools and methods that are broadly relevant to practitioners which can be widely shared within the NS&E community. We, therefore, believe that this area of research should be publicly funded.

The same message was delivered by DuPont's Chairman & CEO and the President of Environmental Defense, in an article they coauthored earlier this year in the Wall Street Journal. To quote from this article, "Our government also needs to invest more seriously in the research necessary to understand fully nanoparticle behavior."

However, the challenge is greater than the mere allocation of additional funds for SHE research. The mechanism by which federal research funds are allocated today for NS&E is designed to support and accelerate discovery and innovation across a wide spectrum of autonomous agencies, and to foster unfettered creativity in identifying new innovation opportunities. However, we believe that there is a better model for supporting research relating to SHE questions. A more actively managed, strategically targeted, and carefully coordinated approach is needed to achieve our common goal. This goal is to systematically develop the measurement tools, test methods and rigorous, peer-reviewed data that will enable nanotechnology to deliver on its promise. The preferred SHE research model would, therefore, take a more prescriptive approach to the selection and prioritization of research topics, and would establish metrics to measure progress against defined targets.

In conclusion:

- We believe that Nanoscale Science and Engineering is an important field of knowledge, with rich potential to enable breakthrough innovations that improve the quality of life in many sectors. To fully realize this potential, we need to understand the SHE implications of nanoscale materials.
- Systems need to be agreed and established through a cooperative effort among all the stakeholders, to address and resolve the key uncertainties, and to provide appropriate mechanisms for risk assessment and risk management.
- DuPont is already collaborating actively on the development of a rigorous and consistent terminology, screening strategies, workplace safety measurements and controls, and a framework to define a systematic and disciplined process to identify, manage and reduce potential SHE risks of nanoscale materials across all lifecycle stages.
- Federal and private funding for research that addresses safety, health and environmental concerns needs to be coordinated and strategically targeted to achieve the maximum impact in the shortest time.

Thank you. I will be happy to answer any questions.